PRELIMINARY IN-HOUSE BENCH EVALUATION OF AQUADISK® CLOTH FILTER MEDIA TECHNOLOGY FOR REDCUING THE LEVELS OF TSS AND TURBIDITY IN TWO TREATED WASTEWATER STREAMS TO MEET CALIFORNIA'S TITLE 22 REUSE CRITERIA FOR SONOMA VALLEY WASTEWATER TREATMENT PLANT

September 7, 2005

Aqua-Aerobic Systems, Inc.
Department of Research & Development

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TITLE OF STUDY:

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OBJECTIVES OF STUDY:

Conduct a preliminary in-house bench study to determine the feasibility of using AquaDisk® cloth filter media technology in combination with PA-13 nylon pile media to reduce the TSS and turbidity levels in two (2) of the client's treated wastewater streams in order to satisfy California's Title 22 reuse criteria of <5 mg/L TSS and <2 NTU turbidity. The streams will be a secondary clarifier effluent collected on August 23 and a storage pond return collected on August 30.

Conduct a series of bench-scale jar followed by direct filter tests to identify effective chemical preconditioning protocols that may be used in concert with AquaDisk® technology to reduce the TSS and turbidity values in the client's wastewater streams to meet Title 22 requirements.

FINDINGS AND CONCLUSIONS:

The results of a single bench-scale filter run performed at a 3.25 gpm/ft^2 hydraulic loading rate indicate that the TSS and turbidity levels of the client's secondary clarifier

effluent stream were reduced from 2.3 mg/L and 1.68 NTU to respective 0.2 mg/L and 0.89 NTU average values. These correspond to 91 and 47% removal efficiencies. The data generated during this segment of the study are summarized in Table 1 and are graphically illustrated in Figures 1 and 2. While not stated as a primary objective of this evaluation, influent and composite filtrate particle size distribution analyses were also conducted. The results, summarized in Table 2 and illustrated in Figures 3 and 4, show that filtering the secondary clarifier effluent stream through AquaDisk® PA-13 media significantly reduced influent particle populations in all six (6) measured size channels. Population reduction rates of 23.2, 57.7, 66.2, 76.4, 77.1, and 88.4% were realized the measured ranges of 2-6, 6-10, 10-15, 15-20, 20-30, and >30 microns.

The storage pond return stream was not collected on August 30, therefore no bench testing was initiated. Also, no jar and direct filter testing was performed on the secondary clarifier effluent stream because the sample's TSS and turbidity levels were already well below the maximum Title 22 values.

RECOMMENDATIONS FOR FURTHER STUDY:

In order to evaluate chemical filter aids (coagulants and flocculants), it is recommended that additional bench-scale jar testing be initiated. Such work, however, should be conducted on wastewater generated under upset conditions; in other words, water containing TSS and turbidity values greater than 5 mg/L and 2 NTU that cannot otherwise be satisfactorily treated without chemical addition.

NATURE AND SCOPE OF STUDY:

AquaDisk® No-Chemical Filter Run: Secondary Clarifier Effluent Feedstock:

This segment of the study was completed using the 10 gallons of secondary clarifier effluent stream that was collected at the client's treatment on August 23, 2005. The samples were shipped to Rockford *via* next-day delivery. A small volume of the sample was collected and subjected to in-house TSS, turbidity, and particle size distribution analyses. The results are incorporated into the report text as well as the attached tables and figures.

The as-received clarifier effluent sample was filtered through a hydrated square of virgin AquaDisk® PA-13 nylon pile media that was secured in a vertical orientation inside an hydraulically-controllable acrylic bench-top filtration apparatus. The hydraulic loading rate was set at ~3.25 gpm/ft^2 at the initiation of the filter run. A profile consisting of nine (9) one-liter filtrate samples was collected from the system. A 250-mL portion of each liter sample was transferred into a labeled and sample-rinsed polyethylene bottle for subsequent TSS and turbidity determinations. The remainder of each sample was blended together to formulate a single overall composite filtrate sample that was subjected to an in-house particle size distribution analysis.

Analytical:

All TSS determinations were conducted in-house using Whatman 934-AH™ (1.5-microns) microfiber filter circles and a Mettler-Toledo AT261 DeltaRange® electronic laboratory balance according to Method 2540 D, as prescribed by the 20th Edition (1998) of *Standard Methods for the Examination of Water and Wastewater* (hereafter cited as *Standard Methods*).

All turbidity analyses were performed in-house using a Hach Model 2100N bench-top nephelometric turbidimeter. Please refer to *Standard Methods* for additional commentary pertaining to turbidity determinations.

All particle size distribution analyses were completed in-house using a portable MetOne laser analyzer equipped with a Model WGS267 water grab sampler. The instrument is

pre-programmed to count particles in six (6) discrete size ranges, or channels: 2-6, 6-10, 10-15, 15-20, 20-30, and >30-microns. The counts/100 mL particle results presented in this report represent the average of three (3) consecutive one-minute analytical runs performed at a 100 mLs/minute flowrate. Please see *Standard Methods* for additional comments regarding particle size distribution analyses.

ANALYSIS / DISCUSSION:

The 10-gallon volume of secondary clarifier effluent stream was transferred to a washed and distilled water-rinsed Nalgene® feed tank immediately upon receipt. The as-received water exhibited a very light greenish tint with little turbidity apparent. Some discrete, well-formed suspended solids were however visible. In-house TSS and turbidity analyses of the sample revealed values of 2.3 mg/L and 1.68 NTU, respectively. It should be noted that the client reported that they measured the turbidity at ~1.6 NTU. A particle size distribution analysis of the sample, included in the Table 2 summary and illustrated in Figure 3, shows that almost 93% of the particle counts measured ≤10 microns in size. Conversely, about 7% of the total population measured ≥10 microns. It should be noted that these data represent particle counts (population) rather than actual particle mass. Typically, the bulk of the solids mass is distributed amongst the fewer large particles rather than amongst the many smaller ones.

The TSS and turbidity reduction results of the “no-chemical” AquaDisk® filtration run are summarized in Table 1 and are illustrated in Figures 1 and 2. These data show that the influent TSS and turbidity values were reduced to respective 0.2 mg/L and 0.89 NTU averages over the course of the run. The overall composite filtrate sample was subjected to a particle analysis and the results, incorporated in Table 2 and plotted in Figure 4, indicate that significant population reductions were achieved in the six (6) monitored size channels of 2-6, 6-10, 10-15, 15-20, 20-30, and >30-microns. Respectively, the removal efficiencies were 23.2, 57.7, 66.2, 76.4, 77.1, and 88.4%

As stated previously, none of the planned jar testing of this stream was initiated. This was done for two (2) primary reasons. First, the TSS and turbidity levels of the as-received material were already well below the stated Title 22 requirements. These levels were then significantly reduced in the “no-chemical” AquaDisk® filtration run. Previous investigations have shown that, when added to already very clean streams, chemical filter aids typically only decrease filter quality by increasing TSS and turbidity concentrations. Secondly, evaluating filter aid chemicals on such a stream would not have provided data applicable to dirtier streams that would require chemical preconditioning prior to cloth media filtration.

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TABLE 1

SUMMARY OF AQUADISK® NO-CHEMICAL FILTER RUN CONDITIONS AND RESULTS: SECONDARY CLARIFIER EFFLUENT STREAM

Conditions:

- Influent: Secondary Clarifier Effluent
- Chemical Conditioning: None
- Hydraulic Loading Rate: ~3.25 gpm/ft^2
- Filter Media: AquaDisk® PA-13 nylon pile

SAMPLE NUMBER	SAMPLE DESCRIPTION	THROUGHPUT (L)	TSS[1] (mg/L)	TURBIDITY[2] (NTU)
1	Influent[3]	---	2.3	1.68
2	Filtrate	0-2	0.6	0.94
3	Filtrate	2-4	<0.1	0.88
4	Filtrate	4-6	0.6	0.92
5	Filtrate	6-8	0.1	0.91
6	Filtrate	8-10	<0.1	0.95
7	Filtrate	10-12	0.3	0.96
8	Filtrate	12-14	0.3	0.92
9	Filtrate	14-16	<0.1	0.81
10	Filtrate	16-18	0.3	0.86
11	Filtrate	18-20	<0.1	0.84
12	Filtrate	20-22	<0.1	0.87
13	Filtrate	22-24	<0.1	0.85
14	Filtrate	24-26	<0.1	0.89
	Average Filtrate		**0.2**	**0.89**

Notes:

1. See Figure 1 for a graphic TSS data plot.
2. See Figure 2 for a graphic turbidity data plot.
3. See Table 2 and Figure 3 for influent stream particle size data.

TABLE 2

SUMMARY OF PARTICLE DATA FOR AQUADISK® NO-CHEMICAL FILTER RUN: SECONDARY CLARIFIER EFFLUENT STREAM

Conditions:

- Influent: Secondary Clarifier Effluent
- Chemical Conditioning: None
- Hydraulic Loading Rate: ~3.25 gpm/ft^2
- Filter Media: AquaDisk® PA-13 nylon pile

PARTICLE SIZE CHANNELS (Microns)	INFLUENT		FILTRATE	
	Counts/ 100 mLs	% OF TOTAL[1]	Counts/ 100 mLs	%Reduction[2]
2-6	326,691	83.0	250,844	23.2
6-10	38,719	9.8	16,390	57.7
10-15	14,535	3.7	4,909	66.2
15-20	5,087	1.3	1,198	76.4
20-30	4,993	1.3	1,141	77.1
>30	3,445	0.9	401	88.4

Notes:

1. See Figure 3 for a graphic data plot.
2. See Figure 4 for a graphic data plot.

FIGURE 1: TSS REDUCTION RESULTS OF AQUADISK NO-CHEMICAL FILTER RUN: CLARIFIER EFFLUENT STREAM

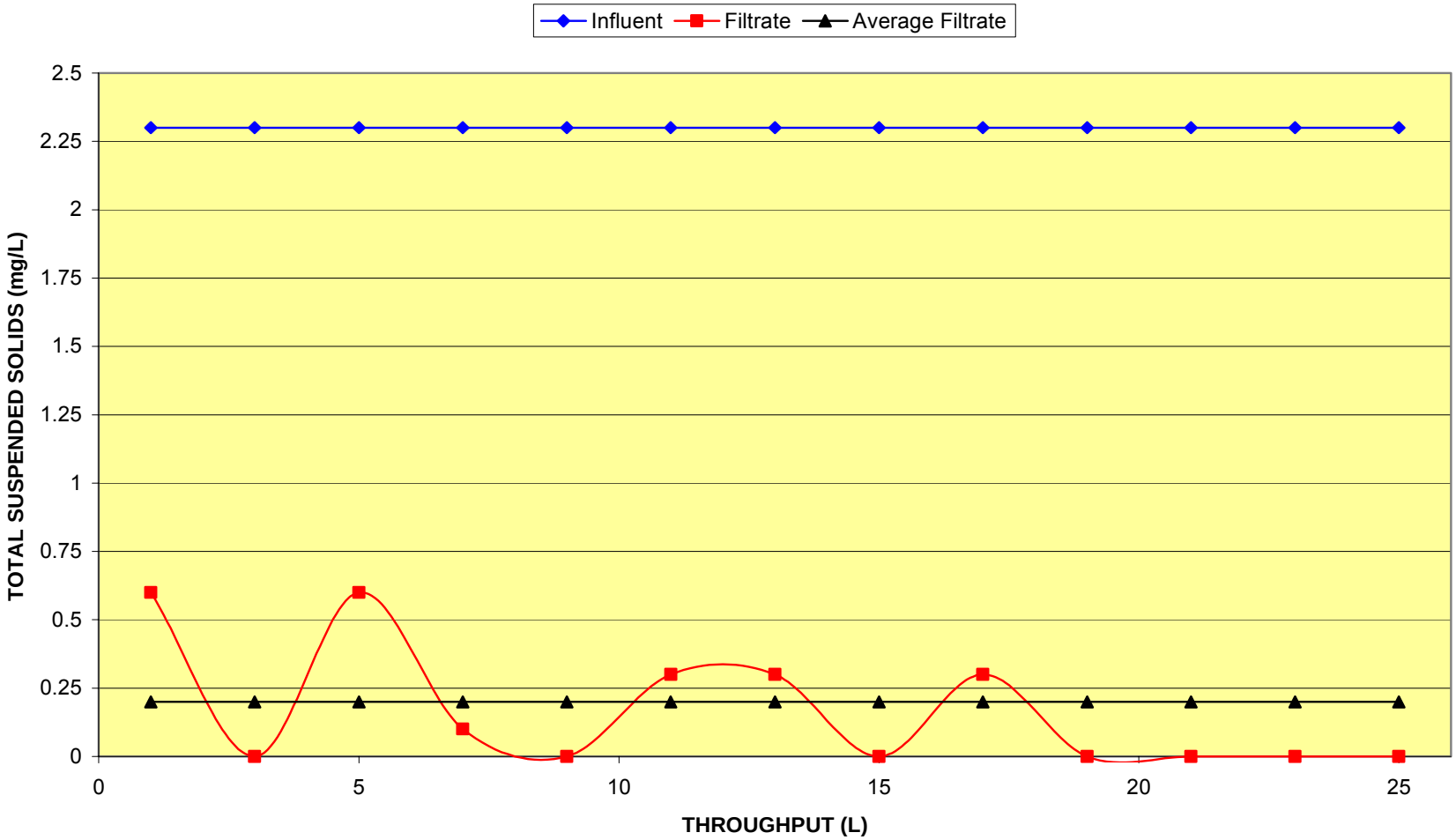

FIGURE 2: TURBIDITY REDUCTION RESULTS OF AQUADISK NO-CHEMICAL FILTER RUN: CLARIFIER EFFLUENT STREAM

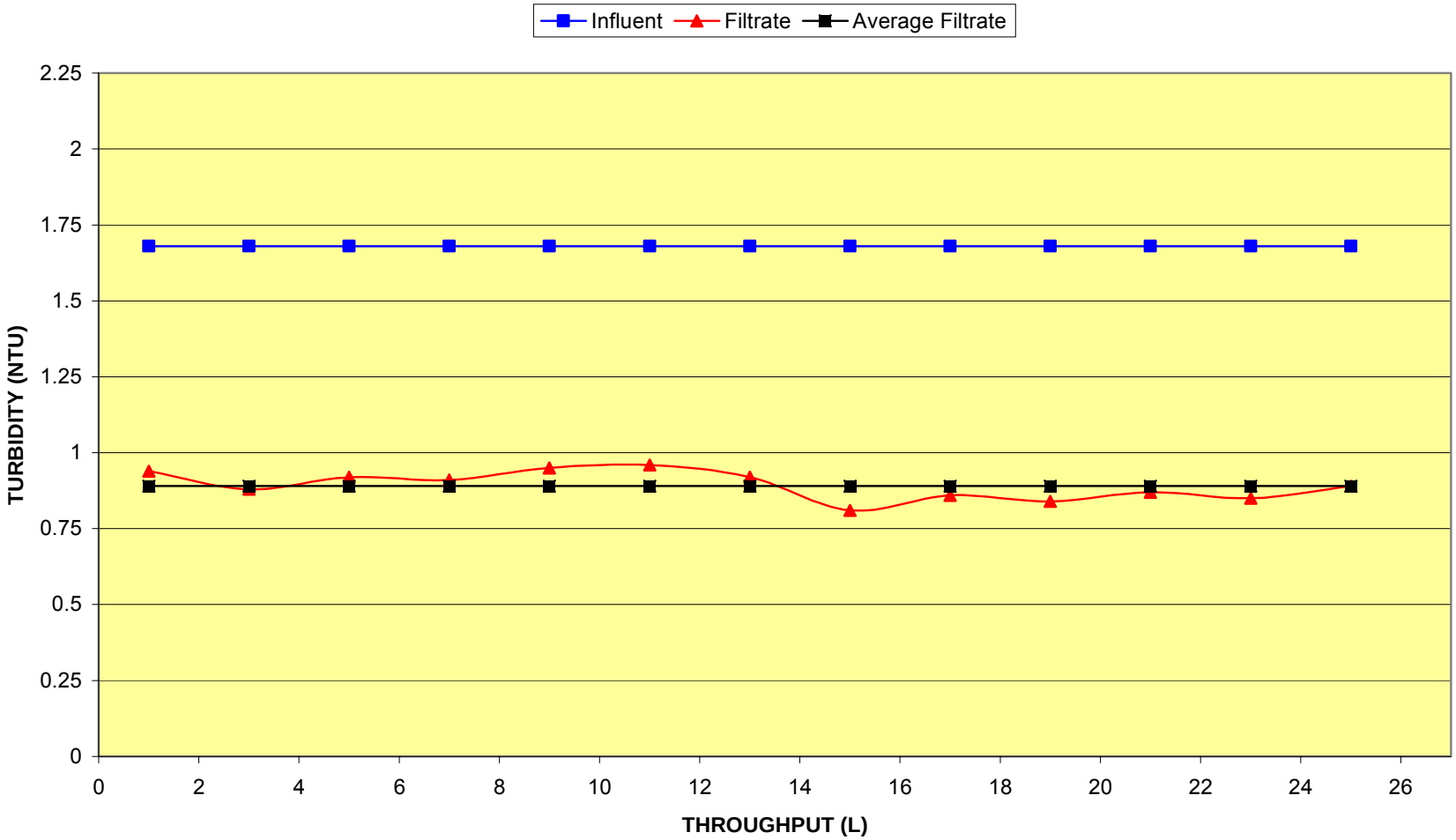

FIGURE 3: AS-RECEIVED SECONDARY CLARIFIER EFFLUENT PARTICLE SIZE DISTRIBUTION

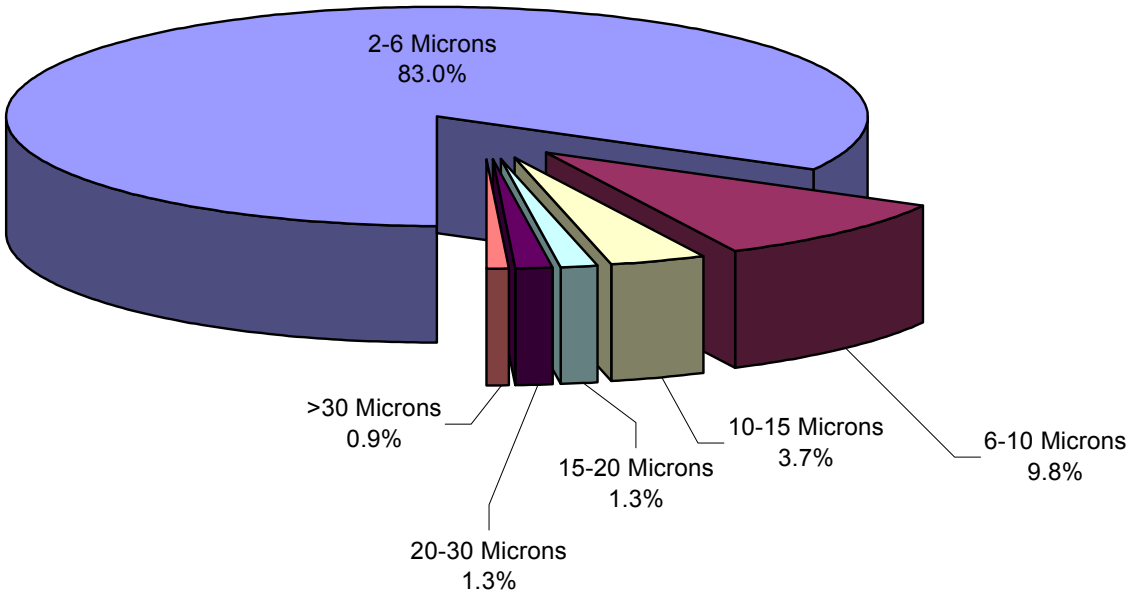

FIGURE 4: PARTICLE REDUCTION DATA FOR AQUADISK NO-CHEMICAL FILTER RUN: SECONDARY CLARIFIER EFFLUENT STREAM